October 25, 2002

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Gentlemen:

In the Matter of	)	Docket No. 50-327
Tennessee Valley Authority	)	

SEQUOYAH NUCLEAR PLANT - UNIT 1 CYCLE 11 (U1C11) 12-MONTH STEAM GENERATOR INSPECTION REPORT

In accordance with the requirements of Sequoyah Unit 1 Technical Specification 4.4.5.5.b, TVA is submitting the 12-month steam generator inspection report that includes the results of inservice inspections performed during the U1C11 refueling outage. Enclosed is the 12-month steam generator inservice inspection report that addresses the active and potential damage mechanisms identified in the Sequoyah Unit 1 Degradation Assessment.

This letter is being sent in accordance with NRC RIS 2001-05. If you have any questions, please call me at (423) 843-7170 or Jim Smith at (423) 843-6672.

Sincerely,

Original signed by

Pedro Salas
Licensing and Industry Affairs Manager

ENCLOSURE

TENNESSEE VALLEY AUTHORITY
SEQUOYAH NUCLEAR PLANT (SQN)

12-Month Steam Generator Inspection Report

(Unit 1 Cycle 11 Refueling Outage)

Table of Contents

INTRODUCTION

During the scheduled Sequoyah Nuclear Plant (SQN) Unit 1 End of Cycle 11 (EOC-11) refueling outage, extensive inservice inspections were conducted in all four steam generators (SGs). The SQN Unit 1 Cycle 11 Degradation Assessment projected the extent of the various active and potential degradation mechanisms based on industry experience of plants with Westinghouse Model 51 SGs. The inspection was focused on the detection and evaluation of the active and potential degradation mechanisms.

The results of the inspections were classified as follows:

	SG1	SG2	SG3	SG4
Bobbin	C-2	C-2	C-2	C-2
TTS RPC	C-2	C-2	C-2	C-2
Freespan Dents	C-1	C-1	C-1	C-1
U-Bend +Point	C-1	C-1	C-1	C-2

Dented intersection inspections are not applicable to the categorization above. A critical area/buffer zone inspection scope has been utilized since EOC-8 consistent with correspondence with the NRC (Reference TVA's Ralph Shell's memo to NRC dated March 12, 1997).

The Alternate Repair Criteria (ARC) for axial outside diameter stress corrosion cracking (ODSCC) at tube support plates (TSPs) continued during this inspection. The report required within 90 days by Generic Letter 95-05, Attachment 1, Section 6.b. was transmitted to NRC by a separate transmittal.

The ARC for axial primary water stress corrosion cracking (PWSCC) at dented TSPs was continued this inspection. The report required by Technical Specification 4.4.5.5.e. was transmitted to the NRC by a separate transmittal.

This report fulfills the reporting requirements of SQN Technical Specification section 4.4.5.5.b for reporting results of SG inservice inspection within 12 months.

SG TUBE INSERVICE INSPECTION SCOPE

The SQN SG tube inservice inspection (ISI) initial sample and expansion samples for all SGs and all damage mechanisms was as follows:

100% full-length bobbin examination in all 4 SGs

100% hot leg top of tubesheet (TTS) WEXTEX transition region examination in all 4 SGs with +Point probe.

100% Row 1, 2, and 3 and 20% of Row 4 U-Bend examinations in all 4 SGs with magnetic biased ZETEC +Point Low Row U-Bend Rotating probe.

100% $\geq$1 volt hot leg dented TSP intersections in all 4 SGs with +Point probe.

100% of <1 volt dented TSP intersections were examined during the bobbin coil examination utilizing the qualified technique for detection of PWSCC. This required extensive analyst training and testing.

20% sample of hot leg freespan dents from TTS to second hot leg TSP

All test techniques used for detection were EPRI Appendix H qualified examination techniques and validated for use at SQN. NDE uncertainties were quantified for analysts and techniques utilized for sizing.

Refer to Attachment 1 for the quantity of the above examinations.

SG TUBE INSPECTION RESULTS

As a result of plugging 195 tubes EOC-11, Unit 1 SGs are 8.5% plugged. SQN Unit 1 is analyzed for up to 15% tube plugging. SQN Unit 1 utilized the Westinghouse rolled plugs during Cycle 11 RFO. Refer to Attachment 2 for a summary of tubes plugged and Attachment 3 for the identification of tubes plugged by damage mechanism.

The plugging status of each SG is described in Table 1 below:

Table 1

	SG1	SG2	SG3	SG4	Total
Previously Plugged	118	175	330	332	955
Plugged EOC-11	30	25	82	58	195
Total Tubes Plugged	148	200	412	390	1150
Percent Plugged	4.4%	5.9%	12.2%	11.5%	8.5%

Main steam line break accident differential pressure is 2560 psi (Pressurizer safety valve setpoint plus 3 percent), and 1.43 times this value provides the accident structural pressure lower limit of 3661 psi. The Steam Generator tubing operating pressure differential during fuel cycle 11 was 1392 psi (2235 psi RCS pressure minus 843 psi Main Steam pressure). Three times the normal differential pressure provides the normal operating structural pressure lower limit of 4176 psi.

Calculation for tube lower limit burst pressures were performed using TubeWorks Version 1.10 by E-Mech Technology, Inc.

Degradation Mechanisms Detected

PWSCC U-Bend

The U1C11 Degradation Assessment predicted ten tubes to be plugged due to axial or circumferential PWSCC in the Row 1, 2, or 3 U-bend region. Row 1 and 2 U-Bends were heat treated In-Situ during March of 1987, however, they had operated several cycles prior to heat treating. It is believed that cracking initiated in the first few cycles in Row 1 and 2 and may have continued to grow to detectable levels. No PWSCC axial nor circumferential degradation was identified in Row 1, 2, 3, or 4 during the EOC-11 outage.

ODSCC U-Bend Axial

The industry database indicated that only a few tubes had been plugged across the industry due to ODSCC in the U-bend region. ODSCC had not previously been detected in the U-bend region at SQN Unit 1 or 2. Due to this, the U1C11 Degradation Assessment did not originally include a prediction for this degradation mechanism for U1C11. However, the +Point rotating probe utilized for PWSCC detection discovered one axial ODSCC indication in SG4 R3 C69. This indication had NDE indicated values for average depth of 58.08%, maximum depth of 70%, length of 0.25 inches and 0.51 max. volts. Condition Monitoring indicated that this indication would have a lower limit burst pressure of 5076 psi. This tube was In-Situ Pressure tested because sizing uncertainties are not quantified and because this was a new degradation mechanism. The tube withstood the 3 times normal operating pressure differential with zero leakage and therefore satisfied condition monitoring performance criteria. This tube was plugged.

PWSCC TTS

The U1C11 Degradation Assessment predicted fifty nine tubes to be plugged due to both axial and circumferential PWSCC at TTS. All PWSCC TTS axial and circumferential indications were plugged on detection and sized using the +Point probe.

A total of 13 PWSCC axial indications were identified. All of these axial indications were below the top-of-tubesheet and therefore could not burst due to the additional structural strength provided by the tubesheet.

Also, axial indications will not allow a tube to be pulled out of the tubesheet. The most limiting PWSCC axial indication within two inches of the top-of-tubesheet was in SG3 R5 C32 (located 0.05 inches below the top of the tubesheet) which had NDE indicated values for average depth of 51.86%, maximum depth of 78%, length of 0.14 inches and 0.26 max. volts. Condition Monitoring assumed this indication was free-span and calculated a lower limit burst pressure of 5991 psi.

A total of 14 circumferential indications were identified. All but one of the PWSCC TTS circumferential indications were below the top-of-tubesheet, however all were analyzed as if they were freespan. Condition Monitoring was performed on all these indications with the most limiting indication in SG3 R5 C32 located at HTS-0.46. This indication had NDE indicated variables which measured 4.79% PDA, 65% max. depth, 40 degrees circumferential extent, and 0.77 max. volts. Condition Monitoring assumed this indication was free span and calculated a lower limit burst pressure of 8694 psi

All PWSCC TTS axial and circumferential indications were below the In-Situ Guideline voltage criteria for performing In-Situ pressure testing for leakage. All PWSCC TTS indications met condition monitoring performance criteria. All PWSCC TTS axial and circumferential indications were plugged.

ODSCC TTS

The U1C11 Degradation Assessment predicted twenty-five tubes to be plugged for axial and circumferential ODSCC at TTS. All ODSCC-TTS axial and circumferential indications were plugged on detection and sized using the +Point probe.

A total of 7 ODSCC axial indications were identified. Condition Monitoring was performed on each. The most limiting ODSCC axial TTS indication is SG2 R7 C77 located at HTS -0.10. This indication had NDE indicated length of 0.24 inches, average depth of 68%, maximum depth of 88% and a max. volts of 0.11 (indications with low voltage such as this one are very likely to have the phase angle pulled by other signals such as deposit or sludge and therefore it is very unlikely that this flaw is as severe as the depth indicates). Condition Monitoring assumed this indication was free span and conservatively calculated a lower limit burst pressure of 4219 psi

A total of 2 circumferential indications were identified. Condition Monitoring was performed on each. The limiting ODSCC TTS circumferential indication is SG2 R4 C59 located at HTS +0.12. This indication had NDE indicated variables which measured 4.36% PDA, a circumferential extent of 43°,a maximum depth of 53% and max volts of 0.10. Condition monitoring calculated a lower limit burst pressure of 8777 psi.

All ODSCC TTS axial and circumferential indications were below the In-Situ Guideline voltage criteria for performing In-Situ pressure testing for leakage. All ODSCC TTS indications met condition monitoring performance criteria.

ODSCC Axial Sludge Pile

A total of five tubes were discovered with ODSCC axial indications above the top-of-tubesheet in the sludge pile region. The inspection scope above the top of the tubesheet covers the sludge pile region. Condition Monitoring was performed on each indication. The most limiting ODSCC axial sludge pile indication was SG 1 R18 C34 at HTS+0.60. This indication was 0.18 inches long and had an average depth of 55.78%, a maximum depth of 81%, and a maximum voltage of 0.09. The very low voltage of the sludge pile indications easily allows deposit signals to pull the phase angle such that depth over calls results. The calculated lower limit burst pressure for this indication was 5428 psi.

All ODSCC axial sludge pile indications were below the In-Situ Guideline voltage criteria for performing In-Situ pressure testing for leakage. All ODSCC Axial Sludge Pile indications met condition monitoring performance criteria. All ODSCC Axial Sludge Pile indications were plugged.

ODSCC Axial Free Span at Dent

One tube (SG3 R29 C60) was discovered with a ODSCC axial indication in the free span just above the first tube support plate intersection (H01+0.74, i.e. 0.74 inches above the center of the first hot leg tube support plate). This indication was associated with a dent. Condition Monitoring was performed on this indication. The indication was 0.21 inches long and had an average depth of 27.95%, a maximum depth of 36%, and a voltage of 0.17. The calculated lower limit burst pressure for this indication was 7608 psi.

This indication was below the In-Situ Guideline voltage criteria for performing In-Situ pressure testing for leakage. This ODSCC Axial Free Span At dent indication met condition monitoring performance criteria. This tube was plugged.

PWSCC TSP

An ARC for PWSCC at dented tube support plates was previously implemented. This ARC is continuing during fuel cycle 12 operation. A condition monitoring and operational assessment for axial PWSCC at dented TSPs was transmitted to the NRC in a separate transmittal.

The U1C11 Degradation Assessment predicted forty-five tubes to be plugged due to PWSCC circumferential cracking in dented TSPs. A total of 41 indications were identified with PWSCC TSP circumferential cracking even though the +Point inspection scope doubled from the U1C10 inspection scope. All PWSCC TSP circumferential indications were plugged on detection and sized using the +Point probe. All circumferential indications were inside the TSPs. Condition Monitoring was performed on all indications. The most limiting indication was SG3 R8 C8 at H04+0.04. This indication measured 7.13 PDA, had a circumferential extent of 72°, a maximum depth of 95% and a max. volts of 0.16. The calculated lower limit burst pressure for this indication was 8483 psi.

All PWSCC TSP circumferential indications were below the In-Situ Guideline voltage criteria for performing In-Situ pressure testing for leakage. The PWSCC TSP Circumferential indications met condition monitoring performance criteria. All PWSCC TSP Circumferential indications were plugged.

ODSCC TSP

The ARC for axial ODSCC at TSPs continued to be implemented this inspection and a detailed condition monitoring and operational assessment report has been transmitted separately.

The U1C11 Degradation Assessment predicted 65 tubes to be plugged due to ODSCC circumferential cracking at dented tube support plate intersections. A total of 32 circumferential ODSCC indications were detected even though the inspection scope doubled from the U1C10 inspection scope. All circumferential ODSCC TSP indications were plugged on detection and sized using the +Point probe. All indications were within the TSP. Condition Monitoring was performed on all indications. The most limiting indication was SG4 R7 C33 at H02-0.18. This indication measured 12.01 PDA, had a circumferential extent of 73 degrees with a maximum depth of 85%. The calculated lower limit burst pressure was 8395 psi.

All ODSCC TSP circumferential indications were below the In-Situ Guideline voltage criteria for performing In-Situ pressure testing for leakage. The ODSCC TSP circumferential indications met condition monitoring performance criteria. All ODSCC TSP circumferential indications were plugged.

Volumetric Indications

Nine volumetric indications were identified during the U1C11 inspection. +Point probe examinations and bobbin coil examinations were performed. The best available sizing technique used a combination of two examinations. The sizing qualification for ODSCC HTS +Point was utilized to obtain axial length. Cold Leg Thinning maximum depth sizing (determined by bobbin coil - ETSS 96001.1 Rev 6 Jan 2001) was utilized. Condition Monitoring was performed on all indications. The most limiting indication was SG3 R5 C25 at HTS+0.25. This indication had an axial length of 0.28 inches and a maximum depth of 51%. The calculated lower limit burst pressure was 4608 psi.

The volumetric indications met condition monitoring performance criteria. All nine of volumetric indications were plugged.

All nine of these Volumetric indications were of very small amplitude (i.e. the largest being 0.23 volts). One of these Volumetric indications was an ID indication located at HTS-0.95 (0.95 inches below the top of the tubesheet). A review of history found this indication and determined it to be unchanged and it was characterized as a manufacturing flaw. The other eight indications were on the tubing OD. A review of history found seven of these to be unchanged and they were characterized as manufacturing flaws. The eighth indication was located within a first hot leg tube support plate with a dent of 2.259 volt amplitude. This indication was characterized as non-crack-like and could be IGA.

AVB Wear

Based on past indications and growth rate data from past outages, two tubes were predicted to be plugged for AVB wear. A total of 70 indications in 38 tubes were detected. One tube (SG2 R33 C49) exceeded the 40% repair limit and was plugged. The 40% repair limit is conservative for SQN Unit 1 SGs for structural and leakage performance criteria. Condition Monitoring assumed the axial length of the AVB Wear indications to be the width of the AVB (0.375”) Therefore, the most limiting indication of 45% maximum depth had a calculated lower limit burst pressure of 5817 psi.

AVB Wear indications met condition monitoring performance criteria.

Cold Leg Thinning

The U1C11 Degradation Assessment predicted two tubes to be plugged for cold leg thinning. A total of 36 indications were detected with eight indications exceeding the repair limit of 40% through wall and therefore plugged. The 40% repair limit is conservative for SQN Unit 1 SGs for structural and leakage performance criteria. Condition Monitoring assumed the axial length of Cold Leg Thinning to be the tube support plate thickness (0.75”). Therefore, the most limiting indication of 50% maximum depth had a calculated lower limit burst pressure of 4661 psi.

Cold Leg Thinning indications met condition monitoring performance criteria.

Mixed Mode Cracking

At the EOC-11 inspection there were a total of 18 occurrences of both axial and circumferential indications at the same locations. All of these locations were removed from service by plugging. Axial and circumferential indications at the same location occurred in SG 1 with only 1 incident, in SG 2 with 3 incidents, and in SG 3 with 14 incidents (SG 4 did not have axial and circumferential indications at the same location). One occurrence of both axial and circumferential indications at the same location in SG 3 was within the hot leg top-of-tubesheet (i.e., below the top of tubesheet such that the tubesheet would preclude tube rupture) but were separated by more than 0.25 inches and therefore would not degrade the burst pressure. One occurrence of both axial and circumferential indications at the same location in SG 2 was above the top-of-tubesheet in the sludge pile region (i.e., 1.49 inches above the hot-top-of-tubesheet) but were separated by more than 0.25 inches and therefore would not degrade the burst pressure. The remainder of the 18 occurrences were at TSPs. Crack tip to crack tip separation distance of 0.25 inches is sufficient to preclude interaction effects at $3\Delta P$ pressure levels even for 100% through wall cracks as discussed in WCAP-15579. In only eight cases were the axial and circumferential cracks close enough to consider them as possibly interacting and all eight cases were at tube support plate intersections. None of the interacting mixed mode cracks were close to being 100% through-wall and no individual axial or circumferential cracks presented a near challenge to the 1.43 times MSLB ΔP minimum burst pressure requirement for TSP locations. As discussed in WCAP-15579, this fact alone is sufficient to rule out any interaction as significant to structural integrity requirements. The eight possibly interacting locations had shapes best described as “L’s,” “T’s,” and “+’s.”

Two of the eight possibly interacting locations had OD axial and OD circumferential indications. When axial and short circumferential cracks interact, the burst pressure of the axial indication is the most limiting. The maximum length of the possibly interacting OD circumferential indications was 67 degrees (0.405 inches) and the maximum length of the OD axial indications was 0.744 inches with a flaw length degraded area of 49.78%. The calculated lower limit burst pressure for this limiting OD axial indication was 5130 psi. Even reducing the calculated burst pressure by 25% (the maximum reduction observed in testing documented in WCAP-15579) maintained the lower limit burst pressure above 1.43 times Main Steam Line Break pressure of 3661 psi. Therefore, condition monitoring indicates mixed mode of the OD axial and circumferential indications at TSPs is not a structural integrity issue.

Six of the eight possibly interaction locations had ID axial and ID circumferential indications. When axial and short circumferential cracks interact the burst pressure of the axial indication is the most limiting. The maximum length of the possibly interacting ID circumferential indications was 67 degrees (0.482 inches), the maximum length of the ID indications was 0.17 inches, and the greatest maximum depth was 46%. The lower limit burst pressure for the limiting axial ID indications was 5980 psi. Even reducing the calculated burst pressure by 25% (the maximum reduction observed in testing documented in WCAP-15579) maintained the lower limit burst pressure above 1.43 times Main Steam Line Break pressure of

3661 psi. Therefore condition monitoring indicates mixed mode of the ID indications is not a structural integrity issue.

From an operational assessment perspective, similar low frequency of axial and circumferential cracks in close enough proximity to be considered as interacting can be expected. Also, similar 95th percentile crack sizes can be expected. Table 2 below identifies the 95th percentile crack length and maximum depths from EOC-11 inspection

Three scenarios of mixed mode interaction are evaluated below for Operational Assessment.

Axial ODSCC indications at TSP were detected with interacting circumferential indications during the EOC-11 inspection. During EOC-11 inspection no axial ODSCC at TSP were greater than 2.0 volts. A worst case 2.0 volt axial ODSCC bobbin voltage projected to EOC-12 would be 3.3 volts (i.e., 20.5% NDE uncertainty, 30%/EFPY growth, and 1.26 EFPYs planned Cycle 12 length). A 3.3 bobbin volt axial ODSCC at TSP converts to an estimated lower limit burst pressure of about 4600 psi. For axial crack dimensions in the range indicated by this burst pressure, test data in WCAP-15579 points to about a 10% reduction for an interaction with a 100% through-wall circumferential crack. The interaction of the 95th percentile worst case axial ODSCC cracks and circumferential cracks does not produce a challenge to required minimum burst strengths of 1.43 MSLB at TSPs. Given the very low frequency of axial and circumferential cracks being close enough to even consider interaction, assuming an interaction at bounding 95th percentile degradation sizes is very conservative. Additionally, the low bobbin voltage levels at SQN Unit 1 argue against the possibility of axial and circumferential crack depths needed to consider possible interactions, strong enough to challenge minimum structural integrity.

Table 2

Degradation Mechanism	Upper 95th Percentile Length	Upper 95th Percentile Maximum Depth	Lower Limit Burst Pressure
Axial PWSCC at TSP	0.41”	56%	4178 psi (1)
Axial ODSCC at TSP	0.75” (assumed)	3.3 volts	4600 psi
Axial ODSCC at TTS	0.30”	53%	4849 psi
Circ PWSCC at TSP	0.65”	75%	7013 psi (2)
Circ ODSCC at TSP	0.77”	46%	7256 psi (2)
Circ ODSCC at TTS	0.33	55%	8287 psi (2)

Note (1) Burst pressure calculated assuming Max. Depth over entire crack length.

Note (2) Burst pressure calculated assuming 100% TW over entire circumferential. crack length.

Axial PWSCC indications at TSPs were detected with interacting circumferential indications during the EOC-11 inspection. The length of the axial crack is the dominant consideration for combined axial and circumferential cracks when the circumferential cracks are of limited extent. An axial PWSCC indication with a 95th percentile depth and 95th percentile length would have a lower limit burst pressure of 4178 psi. Decreasing the lower limit burst pressure by 10% to account for an interacting 95th percentile circumferential crack would result in a burst pressure of 3760 psi which is still above 1.43 times Main Steam Line Break pressure (3661 psi). Given the very low frequency of axial and circumferential cracks being close enough to even consider interaction, the assumption of interaction at bounding 95th percentile degradation sizes is very conservative. WCAP-15579 indicated mixed mode cracking was considerably strengthened if the axial legs are not completely through-wall. Through wall axial flaws burst by first bulging open and then tearing at the crack tips. When a partial depth circumferential crack intersects the tip of an axial through-wall crack, the circumferential crack tends to tear as the axial crack bulges and generates additional axial stresses. Axial PWSCC occurs at dented TSP intersections. The presence of the dented TSP precludes the tube from bulging and therefore provides structural strength. Also, because the TSP is dented, it is not likely that the TSP will deflect during a postulated Main Steam Line Break accident to expose the crack to freespan conditions. Additionally, the testing documented in WCAP-15579 utilized EDM slots to simulate cracks. The limited test data on combined axial and circumferential crack shows that with comparable dimensions, combined EDM slots are not as strong as actual stress corrosion cracks. An additional conservatism is that the lower limit burst pressure was calculated utilizing the Max. Depth over the entire crack length. In summary, an axial PWSCC indication with a 95^{th} percentile depth and 95^{th} percentile length would have a lower limit burst pressure greater than 1.43 times Main Steam Line Break pressures even if reduced 10% to account for interaction with a circumferential crack of 95^{th} percentile length and depth.

One incidence of ODSCC at TTS was detected with both axial and circumferential cracks at the same location during EOC-11. Calculations to determine the lower limit burst pressure requires the Average Depth (or effective structural depth) be input. To obtain an Average Depth, the 95^{th} percentile Max. Depth was multiplied by 0.95 to obtain the average depth (a 5% reduction is conservative when compared to the EOC-11 TTS ODSCC Axial crack data where the typical Average Depth to Max. Depth ratio is 0.66 and the greatest Average Depth to Max. Depth ratio was 0.81). Using this conversion to Average Depth, an axial ODSCC of 95^{th} percentile max. depth and 95^{th} percentile length would have a lower limit burst pressure of 4849 psi. Even with a 10% reduction in burst pressure due to the interaction of a 95^{th} percentile circumferential, the crack burst pressure would be 4364 which still remains above the $3\Delta P$ pressure (i.e. 4179psi).

The 10% reduction in the burst pressure is reasonable due to the Max. Depth value being far from 100% through-wall.

Leakage integrity for mixed mode cracking is not an issue due to the limited number of incidents of mixed mode cracking and also the fact that the 95^{th} percentile Max. Depths are not near 100%.

In summary, all locations with mixed mode cracking meet leakage and structural integrity performance criteria for condition monitoring and operational assessment.

Preventive Plugging

During the SQN Unit 1 Cycle 11 refuel outage, TVA took a very conservative approach to disposition non-crack-like indications that have been tracked from past inspections and preventively plugged 22 tubes. These tubes had volumetric indications. The past inspection bobbin coil data was reviewed and no change indicative of an active damage mechanism was seen in any of these indications. For example, during the SQN Unit 1 Cycle 1 refuel outage, wear was discovered at the Flow Lane Blocking Device (i.e. row 1 hot and cold legs approximately 17 inches above the top of tubesheet) TVA removed this device during the cycle 1 refuel outage and has been tracking these indications without detecting any change in the indications for the past 10 fuel cycles. Another example of preventively plugging was indications which TVA had previously characterized as MBM's (i.e. Manufacturing Burnish Marks). TVA has also tracked these MBM indications since the first refuel outage without detecting any change in these indications. Another example of preventively plugging was of row 1 and 2 tubes in which noise in the +Point data of the U-bend region could possibly have covered an indication. In summary, TVA conservatively plugged tubes preventively during the Unit 1 Cycle 11 outage to ensure compliance with all industry standards and to ensure the safe and reliable operation of the unit until the next refuel outage.

SECONDARY SIDE INSPECTION SCOPE AND RESULTS

Cracked Support Plate Indications

Cracked tube support plate indications (CSIs) are indications of cracks in the tube support plates and not necessarily indicative of tube degradation. These are detected during 100% automated analysis of bobbin data.

SQN unit 1 SGs do not have extensive support plate cracking. Cracked TSPs were evaluated for potential star drop-out conditions and none were identified. Therefore, design basis function of the support plate has not been lost. There is also no evidence of wrapper drop or wrapper degradation.

Upper Internals Inspection

No upper internals inspection was performed during this inspection.

Sludge Lancing

Sludge lancing was not performed due to this outage being the final outage before SG replacement.

Foreign Object Search and Retrieval (FOSAR)

Foreign object search and retrieval was completed on all four SGs prior to closure and all identified foreign objects were retrieved.

CONCLUSIONS

The NDE testing completed on the SQN Unit 1 SGs and plugging of defective tubes met the Technical Specification and ASME Section XI code requirements for inservice inspection and structural and leakage integrity has been demonstrated; therefore, each SG has been demonstrated operable.

Utilization of two Alternate Repair Criteria continued in accordance with the Unit 1 Technical Specification Surveillance Requirement 3/4.4.5.4.a.10 and 3/4.4.5.4.a.11.

Based on the criteria of 10 CFR 50.59, TVA concludes that the integrity of the SQN Unit 1 SGs was maintained during Cycle 11 operation and will be maintained through fuel Cycle 12 and does not represent an unreviewed safety question.

REFERENCES

1. WCAP-15579, "Burst Pressure Data for Steam Generator Tubes with Combined Axial and Circumferential Cracks", Westinghouse Proprietary Class 2, Westinghouse Electric Company LLC, September, 2000.

2. WCAP-15128, Rev. 3, "Depth-Based SG Tube Repair Criteria for Axial PWSCC at Dented TSP Intersections", Westinghouse Proprietary Class 2, Westinghouse Electric Company LLC, June, 2000.

3. Keating, R. F., and Begley, J. A., "Steam Generator Tubing Flaw Handbook", EPRI Report TR-1001191-L, EPRI, Palo Alto, CA, January 2001.

4. “PWR Steam Generator Examination Guidelines”, Performance Demonstration Database, Appendix A, Technique Specification Sheets, ETSS 96702, EPRI, Palo Alto, CA, January, 1999.

5. EPRI TR-107197, "Depth Based Structural Analysis Methods for SG Circumferential Indications, EPRI, Palo Alto, CA, November, 1997.

6. Zahoor, A., "Ductile Fracture Handbook", EPRI Report RP-1757-6-69, EPRI, Palo Alto, CA, January, 1991.

7. Keating, R. F., Westinghouse Electric Co., Madison, PA, unpublished presentation the NRC, May 15, 2000

DEFINITIONS

+Point - An RPC eddy current probe in which two coils are placed against the same contact surface with their axis 90 degrees apart. When the probe face is viewed, the coils create the appearance of a '+'. This configuration minimizes the eddy current response to tubing geometry changes or support structures and is presently considered the probe with the best overall crack detection capabilities.

ARC - Alternate Repair Criteria

EOC - End of Cycle

EPRI - Electric Power Research Institute

H01 - First hot leg tube support plate intersection

H02 - Second hot leg tube support plate intersection

H03 - Third hot leg tube support plate intersection

H04 - Fourth hot leg tube support plate intersection

H05 - Fifth hot leg tube support plate intersection

H06 - Sixth hot leg tube support plate intersection

H07 - Seventh hot leg tube support plate intersection

ODSCC - Outside Diameter Stress Corrosion Cracking

PDA - Percent Degraded Area

PWSCC - Primary Water Stress Corrosion Cracking

RPC - Literally 'Rotating Pancake Coil' eddy current probe. This term is also used to describe eddy current probes in which the coil face contacts the tube wall while rotating and being pulled through the tube axially such that the examination path is helical.

SQN - Sequoyah Nuclear Power Plant

TSP - Tube Support Plate

TTS - Top of Tubesheet

WEXTEX - Westinghouse Explosive Tube Expansion

ATTACHMENT 1

SQN UNIT 1
CYCLE 11 RFO
NUMBER AND EXTENT OF TUBES EXAMINED

EDDY CURRENT EXAM TYPE	SG 1	SG 2	SG 3	SG 4	Total
Full Length Bobbin Coil	3270	3213	3058	3056	12597
U-Bend Plus Point	280	285	244	242	1051
Top of Tubesheet Plus Point	3270	3213	3058	3056	12597
Dented Freespan Plus Point	13	14	9	9	45
H01 Plus Point	577	354	1365	1994	4290
H02 Plus Point	97	148	897	852	1994
H03 Plus Point	193	154	1023	1676	3046
H04 Plus Point	94	165	1295	953	2507
H05 Plus Point	146	201	472	432	1251
H06 Plus Point	168	250	850	194	1462
H07 Plus Point	225	289	365	345	1224
Diagnostice Plus Point	107	89	281	239	716
RPC exams	*1607*	*1650*	*6548*	*6685*	*15774*
Total Exams Completed	8440	8375	12917	13048	42780
Total Tubes Examined	3270	3213	3058	3056	12597

Note: The RPC Exams Totals above are only +Point examinations at dented tube support plate intersections and do not include diagnostic +Point or TTS +Point examinations.

ATTACHMENT 2

SQN UNIT 1 CYCLE 11 RFO
SUMMARY OF SG TUBE PLUGGING

PLUGGING STATUS	SG 1	SG 2	SG 3	SG 4	Total
Previously Plugged Tubes	118	175	330	332	955
Damage Mechanism					
AVB WEAR	0	1	0	0	1
COLD LEG WASTAGE	4	0	2	2	8
ODSCC FREESPAN	0	0	1	0	1
ODSCC HTS AXIAL	0	6	1	0	7
ODSCC HTS CIRC	0	2	0	0	2
ODSCC TSP AXIAL	1	2	9	5	17
ODSCC TSP CIRC	4	1	12	13	30
PREVENTATIVE	5	2	11	4	22
PWSCC HTS AXIAL	1	1	5	4	11
PWSCC HTS CIRC	5	2	2	4	13
PWSCC TSP AXIAL	1	3	9	15	28
PWSCC TSP CIRC	3	2	26	10	41
ODSCC U-BEND AXIAL	0	0	0	1	1
SLUDGE PILE	3	0	1	0	4
VOLUMETRIC INDICATION	3	3	3	0	9
Plugged Cycle 11	30	25	82	58	195
TOTAL TUBES PLUGGED	148	200	412	390	1150

Effective Plugging Percentages

SG 1	4.4%
SG 2	5.9%
SG 3	12.2%
SG 4	11.5%

ATTACHMENT 3

SQN UNIT 1 CYCLE 11 RFO
STEAM GENERATOR 1
TUBES PLUGGED BY DAMAGE MECHANISM

SG	ROW	COL	Indication	Location	Characterization
1	28	11	50	C01-.04	C/L WASTAGE
1	32	77	44	C01+.06	C/L WASTAGE
1	34	16	44	C01-.08	C/L WASTAGE
1	34	17	44	C01-.04	C/L WASTAGE
Plugged 4					
1	29	67	SOI	H01+.00	ODSCC TSP AXIAL
Plugged 1					
1	9	56	SCI	H01+.19	ODSCC TSP CIRC
1	14	64	SCI	H01+.18	ODSCC TSP CIRC
1	15	61	SCI	H02+.12	ODSCC TSP CIRC
1	18	59	SCI	H01+.23	ODSCC TSP CIRC
Plugged 4					
1	1	90	VOL	HTS+17.71	PREVENTIVE
1	1	91	VOL	HTS+17.70	PREVENTIVE
1	1	92	VOL	HTS+17.66	PREVENTIVE
1	1	94	VOL	HTS+17.62	PREVENTIVE
1	24	23	TBP	+0.00	PREVENTIVE
Plugged 5					
1	4	42	SAI	HTS-2.02	PWSCC HTS AXIAL
Plugged 1					
1	11	30	SCI	HTS-.17	PWSCC HTS CIRC
1	11	68	SCI	HTS-.17	PWSCC HTS CIRC
1	29	52	SCI	HTS-.09	PWSCC HTS CIRC
1	29	54	SCI	HTS-.05	PWSCC HTS CIRC
1	30	55	SCI	HTS-.12	PWSCC HTS CIRC
Plugged 5					
1	12	60	SAI	H01+.63	PWSCC TSP AXIAL
Plugged 1					
1	26	64	SCI	H01+.21	PWSCC TSP CIRC
1	28	35	SCI	H01-.16	PWSCC TSP CIRC
1	35	29	SCI	H01-.03	PWSCC TSP CIRC
Plugged 3					
1	2	32	SAI	HTS+1.05	SLUDGE PILE
1	7	55	SAI	HTS+1.36	SLUDGE PILE
1	18	34	SAI	HTS+.60	SLUDGE PILE
Plugged 3					
1	13	62	SVI	HTS+2.88	VOLUMETRIC
1	14	63	SVI	HTS+2.74	VOLUMETRIC
1	31	14	SVI	HTS+.49	VOLUMETRIC
Plugged 3					
GrandTotal_SG: 30					

ATTACHMENT 3

SQN UNIT 1 CYCLE 11 RFO
STEAM GENERATOR 2
PLUGGED TUBES BY DAMAGE MECHANISM

SG	ROW	COL	Indication	Location	Characterization
2	33	49	45	AV2+.00	AVB WEAR
Plugged 1					
2	4	17	SAI	HTS-.01	ODSCC HTS AXIAL
2	4	82	SAI	HTS-.12	ODSCC HTS AXIAL
2	7	77	SAI	HTS-.10	ODSCC HTS AXIAL
2	10	71	SAI	HTS-.12	ODSCC HTS AXIAL
2	17	64	SAI	HTS-.17	ODSCC HTS AXIAL
2	22	49	SAI	HTS+.23	ODSCC HTS AXIAL
Plugged 6					
2	4	59	SCI	HTS+.12	ODSCC HTS CIRC
2	9	30	SCI	HTS+.13	ODSCC HTS CIRC
Plugged 2					
2	10	4	DSI	H01+.08	ODSCC TSP AXIAL
2	25	35	DSI	H02-.02	ODSCC TSP AXIAL
Plugged 2					
2	14	37	SCI	H01+.17	ODSCC TSP CIRC
Plugged 1					
2	1	58	TBP	+0.00	PREVENTIVE
2	1	62	TBP	+0.00	PREVENTIVE
Plugged 2					
2	17	66	SAI	HTS-3.80	PWSCC HTS AXIAL
Plugged 1					
2	13	38	SCI	HTS-.15	PWSCC HTS CIRC
2	42	35	SCI	HTS-.75	PWSCC HTS CIRC
Plugged 2					
2	14	35	SAI	H02-.29	PWSCC TSP AXIAL
2	16	44	SAI	H02-.39	PWSCC TSP AXIAL
2	35	54	SAI	H01-.06	PWSCC TSP AXIAL
Plugged 3					
2	7	24	SCI	H01+.31	PWSCC TSP CIRC
2	14	30	SCI	H01+.32	PWSCC TSP CIRC
Plugged 2					
2	10	18	SVI	H01-.09	VOLUMETRIC
2	15	39	SVI	C04+15.50	VOLUMETRIC
2	34	73	SVI	C05+17.50	VOLUMETRIC
Plugged 3					
GrandTotal SG: 25					

ATTACHMENT 3

SQN UNIT 1 CYCLE 11 RFO
STEAM GENERATOR 3
TUBES PLUGGED BY DAMAGE MECHANISM

SG	ROW	COL	Indication	Location	Characterization
3	33	16	43	C01+.10	C/L WASTAGE
3	34	79	37	C01-.19	C/L WASTAGE
Plugged 2					
3	29	60	SAI	H01+.74	ODSCC FREESPAN
Plugged 1					
3	6	43	SAI	HTS+.19	ODSCC HTS AXIAL
Plugged 1					
3	3	66	DSI	H01-.09	ODSCC TSP AXIAL
3	4	42	DSI	H04-.15	ODSCC TSP AXIAL
3	5	86	DSI	H01-.09	ODSCC TSP AXIAL
3	8	30	DSI	H01+.00	ODSCC TSP AXIAL
3	17	65	DSI	H01-.15	ODSCC TSP AXIAL
3	18	53	SOI	H01+.29	ODSCC TSP AXIAL
3	21	39	DSI	H01+.00	ODSCC TSP AXIAL
3	38	56	DSI	H01-.19	ODSCC TSP AXIAL
Plugged 8					
3	2	8	SCI	H01+.28	ODSCC TSP CIRC
3	3	57	SCI	H03+.32	ODSCC TSP CIRC
3	4	84	SCI	H04-.04	ODSCC TSP CIRC
3	5	23	SCI	H01-.31	ODSCC TSP CIRC
3	5	26	SCI	H01+.14	ODSCC TSP CIRC
3	5	87	SCI	H01+.31	ODSCC TSP CIRC
3	12	73	SCI	H03+.15	ODSCC TSP CIRC
3	13	38	SCI	H01+.04	ODSCC TSP CIRC
3	13	70	SCI	H04+.31	ODSCC TSP CIRC
3	14	56	SCI	H06+.08	ODSCC TSP CIRC
3	19	30	SCI	H01+.32	ODSCC TSP CIRC
3	26	70	SCI	H01+.06	ODSCC TSP CIRC
Plugged 12					
3	4	28	SOI	H02+.17	ODSCC TSP OBLIQUE
Plugged 1					
3	1	51	TBP	+0.00	PREVENTIVE
3	1	52	TBP	+0.00	PREVENTIVE
3	2	78	TBP	+0.00	PREVENTIVE
Plugged 3					
3	5	94	BLG	HTS+2.62	PREVENTIVE-BULGE
Plugged 1					

ATTACHMENT 3

SQN UNIT 1 CYCLE 11 RFO
STEAM GENERATOR 3
TUBES PLUGGED BY DAMAGE MECHANISM
(Continued)

SG	ROW	COL	Indication	Location	Characterization
3	1	1	VOL	HTS+17.56	PREVENTIVE-FLBD
3	1	93	DFS	HTS+17.70	PREVENTIVE-FLBD
3	1	94	DFS	HTS+17.64	PREVENTIVE-FLBD
Plugged 3					
3	26	74	TBP	+0.00	PREVENTIVE-PVN
Plugged 1					
3	19	10	VOL	HTS+.51	PREVENTIVE-VOL
3	44	35	TBP	+0.00	PREVENTIVE-VOL
3	44	36	TBP	+0.00	PREVENTIVE-VOL
Plugged 3					
3	6	38	SOI	HTS-2.13	PWSCC HTS AXIAL
3	10	46	SAI	HTS-2.73	PWSCC HTS AXIAL
3	10	70	SAI	HTS-2.68	PWSCC HTS AXIAL
3	20	37	SAI	HTS-.55	PWSCC HTS AXIAL
3	21	42	SAI	HTS-.63	PWSCC HTS AXIAL
Plugged 5					
3	5	32	SCI	HTS-.46	PWSCC HTS CIRC
3	45	39	SCI	HTS-6.48	PWSCC HTS CIRC
Plugged 2					
3	3	88	SAI	H02+.13	PWSCC TSP AXIAL
3	10	66	SAI	H01+.60	PWSCC TSP AXIAL
3	11	46	SAI	H04+.61	PWSCC TSP AXIAL
3	11	68	SAI	H01-.35	PWSCC TSP AXIAL
3	11	85	SAI	H01+.37	PWSCC TSP AXIAL
3	19	64	SAI	H01+.72	PWSCC TSP AXIAL
3	37	56	SAI	H01+.54	PWSCC TSP AXIAL
Plugged 7					

ATTACHMENT 3

SQN UNIT 1 CYCLE 11 RFO
STEAM GENERATOR 3
TUBES PLUGGED BY DAMAGE MECHANISM
(Continued)

SG	ROW	COL	Indication	Location	Characterization
3	2	65	SCI	H01+.14	PWSCC TSP CIRC
3	4	59	SCI	H03+.11	PWSCC TSP CIRC
3	4	70	SCI	H01+.27	PWSCC TSP CIRC
3	8	8	SCI	H04+.04	PWSCC TSP CIRC
3	9	64	SCI	H01+.18	PWSCC TSP CIRC
3	10	35	SCI	H03+.21	PWSCC TSP CIRC
3	10	60	SCI	H03+.16	PWSCC TSP CIRC
3	13	74	SCI	H01+.14	PWSCC TSP CIRC
3	14	52	SCI	H02-.14	PWSCC TSP CIRC
3	15	5	SCI	H02-.01	PWSCC TSP CIRC
3	15	79	SCI	H04+.02	PWSCC TSP CIRC
3	16	86	SCI	H01+.11	PWSCC TSP CIRC
3	18	71	SCI	H01+.23	PWSCC TSP CIRC
3	20	31	SCI	H03-.21	PWSCC TSP CIRC
3	20	39	SCI	H03-.16	PWSCC TSP CIRC
3	21	55	SCI	H01+.24	PWSCC TSP CIRC
3	22	39	SCI	H01+.12	PWSCC TSP CIRC
3	22	46	SCI	H01+.18	PWSCC TSP CIRC
3	23	79	SCI	H01+.24	PWSCC TSP CIRC
3	25	72	SCI	H01+.05	PWSCC TSP CIRC
3	26	65	SCI	H02-.04	PWSCC TSP CIRC
3	26	78	SCI	H01+.05	PWSCC TSP CIRC
3	31	81	SCI	H01+.04	PWSCC TSP CIRC
3	32	78	SCI	H02+.18	PWSCC TSP CIRC
3	35	70	SCI	H01+.27	PWSCC TSP CIRC
3	42	47	SCI	H02+.33	PWSCC TSP CIRC
Plugged 26					
3	4	86	SOI	H02+.18	PWSCC TSP OBLIQUE
3	10	93	SOI	H01+.04	PWSCC TSP OBLIQUE
Plugged 2					
3	27	50	SAI	HTS+.77	SLUDGE PILE
Plugged 1					
3	5	25	SVI	HTS+.25	VOLUMETRIC
3	21	70	SVI	HTS+.25	VOLUMETRIC
3	31	45	SVI	HTS-.95	VOLUMETRIC
Plugged 3					
GrandTotal_SG: 82					

ATTACHMENT 3

SQN UNIT 1 CYCLE 11 RFO
STEAM GENERATOR 4
TUBES PLUGGED BY DAMAGE MECHANISM

SG	ROW	COL	Indication	Location	Characterization
4	36	75	30	C01-.06	C/L WASTAGE
4	36	77	29	C01-.11	C/L WASTAGE
Plugged 2					
4	1	1	DFS	CTS+17.55	FLBD WEAR-PREV
Plugged 1					
4	3	50	DSI	H01+.09	ODSCC TSP AXIAL
4	6	73	DSI	H01+.02	ODSCC TSP AXIAL
4	31	20	DSI	H01+.08	ODSCC TSP AXIAL
4	33	22	DSI	H01+.06	ODSCC TSP AXIAL
Plugged 4					
4	2	31	SCI	H01+.23	ODSCC TSP CIRC
4	4	51	SCI	H02+.37	ODSCC TSP CIRC
4	5	29	SCI	H01-.29	ODSCC TSP CIRC
4	5	50	SCI	H03+.15	ODSCC TSP CIRC
4	7	33	SCI	H02-.18	ODSCC TSP CIRC
4	9	15	SCI	H01+.27	ODSCC TSP CIRC
4	13	34	SCI	H02-.06	ODSCC TSP CIRC
4	20	48	SCI	H01-.11	ODSCC TSP CIRC
4	21	45	SCI	H01+.32	ODSCC TSP CIRC
4	24	43	SCI	H01+.21	ODSCC TSP CIRC
4	31	15	SCI	H01+.28	ODSCC TSP CIRC
4	31	58	SCI	H01-.22	ODSCC TSP CIRC
4	36	44	SCI	H01-.32	ODSCC TSP CIRC
Plugged 13					
4	5	1	SOI	H01+.23	ODSCC TSP OBLIQUE
Plugged 1					
4	3	69	SAI	H07+10.36	ODSCC UBEND AXIAL
Plugged 1					
4	4	91	INR	CTS+.00	PREVENTIVE
Plugged 1					
4	29	60	TBP	+0.00	PREVENTIVE-PVN
4	31	67	TBP	+0.00	PREVENTIVE-PVN
Plugged 2					
4	2	52	SAI	HTS-2.99	PWSCC HTS AXIAL
4	5	60	SAI	HTS-5.66	PWSCC HTS AXIAL
4	9	37	SAI	HTS-2.49	PWSCC HTS AXIAL
4	15	34	SAI	HTS-6.03	PWSCC HTS AXIAL
Plugged 4					

ATTACHMENT 3

SQN UNIT 1 CYCLE 11 RFO
STEAM GENERATOR 4
TUBES PLUGGED BY DAMAGE MECHANISM
(Continued)

SG	ROW	COL	Indication	Location	Characterization
4	12	22	SCI	HTS-.02	PWSCC HTS CIRC
4	15	29	SCI	HTS+.02	PWSCC HTS CIRC
4	15	36	SCI	HTS-.05	PWSCC HTS CIRC
4	18	45	SCI	HTS+.06	PWSCC HTS CIRC
Plugged 4					
4	5	43	SAI	H01+.78	PWSCC TSP AXIAL
4	5	53	SAI	H04+.73	PWSCC TSP AXIAL
4	10	14	SAI	H01+.58	PWSCC TSP AXIAL
4	15	35	SAI	H02+.71	PWSCC TSP AXIAL
4	18	25	SAI	H02-.48	PWSCC TSP AXIAL
4	19	22	SAI	H01+.49	PWSCC TSP AXIAL
4	19	31	SAI	H03+.74	PWSCC TSP AXIAL
4	19	32	SAI	H01+.70	PWSCC TSP AXIAL
4	35	23	SAI	H03+.59	PWSCC TSP AXIAL
4	43	52	SAI	H01+.70	PWSCC TSP AXIAL
Plugged 10					
4	1	8	SCI	H01+.20	PWSCC TSP CIRC
4	4	18	SCI	H01+.23	PWSCC TSP CIRC
4	8	92	SCI	H04-.07	PWSCC TSP CIRC
4	12	25	SCI	H02+.19	PWSCC TSP CIRC
4	12	33	SCI	H01+.31	PWSCC TSP CIRC
4	15	21	SCI	H01+.35	PWSCC TSP CIRC
4	25	11	SCI	H01+.00	PWSCC TSP CIRC
4	26	14	SCI	H01+.16	PWSCC TSP CIRC
4	44	48	SCI	H01+.26	PWSCC TSP CIRC
4	45	50	SCI	H01+.23	PWSCC TSP CIRC
Plugged 10					
4	4	69	SOI	H01+.15	PWSCC TSP OBLIQUE
4	7	55	SOI	H01+.20	PWSCC TSP OBLIQUE
4	18	26	SOI	H01+.15	PWSCC TSP OBLIQUE
4	20	28	SOI	H01-.29	PWSCC TSP OBLIQUE
4	37	26	SOI	H01+.06	PWSCC TSP OBLIQUE
Plugged 5					
GrandTotal_SG: 58					